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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aircraft-based observation of meteoric material in lower stratospheric aerosol particles between 15 and 68° N" *by* Johannes Schneider et al.

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Dear Dr. Renard,

Thank you for your comment to our manuscript. Please find the answers to your comments below in blue color.

Changes in the revised manuscript are printed in red.

This interesting paper presents a nice analysis of the solid material collected in the stratosphere and assumed to originate from meteorites. Nevertheless, I have some troubles with the content of the paper:

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1) How can the authors be sure that the analyzed particles have a non-terrestrial origin? Solid particles originated from Earth during various process, or even produced inside the atmosphere, can have the same chemical elements. Some dynamical processes can lift these particles in the stratosphere.

In fact, we discussed this issue in our manuscript in detail (see Sections 3.2 and 3.3): We have three major arguments:

- The fraction of the observed Fe- and Mg containing particles increases with altitude (Fig. 3).
- The composition (cation mass spectra dominated by Mg and Fe, anion mass spectra by sulfate) excludes other (terrestrial or anthropogenic) sources (other sources show different composition, see Section 3.3).
- Upward transport of tropospheric air masses into the stratosphere occurs mainly in the tropics. However, our data show that in the tropics (here mainly the Asian Monsoon Anticyclone, AMA), the fraction of the Mg- and Fe-containing particle remains low in the lower stratosphere (Fig. 4). See end of Section 3.2: "The observation that the fraction of the iron and magnesium-dominated particle type increases only above the extratropical tropopause layer or mixing layer (Hoor et al., 2002; Hoor et al., 2004; Pan et al., 2004), i.e. 30 K above the tropopause (Fig. 4 b), indicates that the source for this particle type must be above the tropopause, because otherwise, the upwelling air masses in the AMA would contain this particle type also at lower potential temperatures".

2) Confusion is made by the author all along the paper between meteoritic disintegration and interplanetary dust (IDP). Some of the particles of such size (1-300 μm) could be interplanetary dust grains mainly coming from comets, not particles coming from meteorite disintegration. Also, some of these (large) particles can survive the atmospheric entry, as those found in the Antarctica ices. The author must consider

the works done by the teams that collect such particles. Also, interplanetary dust and grains coming from meteorites do not have the same composition as cometary grains. The authors must consider the works done on the composition of cometary grains and interplanetary grains, and not only on the composition of meteorites.

We rewrote the introduction with respect to the subject of IPD and meteoric sources, summarize the different possible contributions under the general term "meteoric material" and use this term from there on in the rest of the paper.

We emphasize that from our data we can not distinguish between the different sources of meteoric material, and clarified that again in the conclusions section of the revised version:

"Our observations of particles with signatures of meteoric material do not clearly indicate the formation history, i.e. whether the material originates from meteoric disintegration by ablation (MSP), fragmentation (MF) or from interplanetary dust particles (IDP), since the meteoric material is at least partially dissolved in sulfuric acid."

3) Since the authors have collected a large number of such grains, they can calculate the total concentration and even the total mass-concentration, and they must verify that these values are consistent with the expected flux of solid material (coming from comets and meteorites) that entry the Earth atmosphere. The author must also consider the concentration of interplanetary dust at Earth level.

Unfortunately, the single particle mass spectrometry technique is not able to provide a mass fraction of certain compounds in one single particle. Thus, we do not know how much mass of meteoric material is contained in the detected particles. For example, a particle may have a diameter of 300 nm and is mainly composed of sulfuric acid, but may contain the meteoric material that originates from one meteor smoke particle (MSP) of a few nm in diameter. It may also be that by collision and coagulation more than one MSP ended up in one stratospheric sulfuric acid-dominated particle. Thus, our method (together with the fact that our data represent only parts of the lower strato-

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sphere) does not allow us to calculate a mass concentration of extraterrestrial material in the atmosphere.

4) We have discussed the problem of the various origins of solid material in the stratosphere, and of the vertical transport of the particles, in the paper now published in “Atmosphere”: J.- B. Renard, G. Berthet, A- C. Levasseur-Regourd, S. Beresnev, A. Miffre, P. Rairoux, D. Vignelles, F. Jégou, Origins and Spatial Distribution of Non-Pure Sulfate Particles (NSPs) in the Stratosphere Detected by the Balloon-Borne Light Optical Aerosols Counter (LOAC), Atmosphere 2020, 11, 1031; doi:10.3390/atmos11101031. We discuss the IDP and meteoritic material confusion done in many papers; we present a summary of the properties of the IDP and of cometary material. The authors must be advised that we had submitted a few month ago in ACP a previous version of our paper, but it was rejected by an associated editor that is in the same laboratory as one author of this Schneider et al. paper. Obviously, we are sure this is just a coincidence. Nevertheless, we encourage the authors to consider our work and to clarify their analysis considering the various sources that can exist for the material they have identified.

Thank you for pointing us to your recent paper in Atmosphere. We will refer to the results you obtained from stratospheric balloon-borne measurements in the revised version of our manuscript. One point we would like to mention is that the particles we are describing (the Mg- and Fe- dominated particles we interpret as meteoric material dissolved in sulfuric acid) represent only a subset of the "none-pure sulfate particles" (NSP) that you describe in your publication. In fact, as also reviewer 2 pointed out (and we discussed in section 3.5), our single particle mass spectrometer has a low detection efficiency for pure sulfuric acid. That means, that almost all particles detected by laser ablation mass spectrometry (using 266 nm ablation laser wavelength) represent NSP. Thus, many of the particles we observed will have terrestrial origin. But, the focus of our present paper is the stratospheric meridional distribution of particles containing meteoric material. Further publications will analyze the nature and sources of the other particles detected during the individual campaigns.

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